Fermi National Accelerator Laboratory

Project X

CW Re-Buncher Cavity Design for Project X

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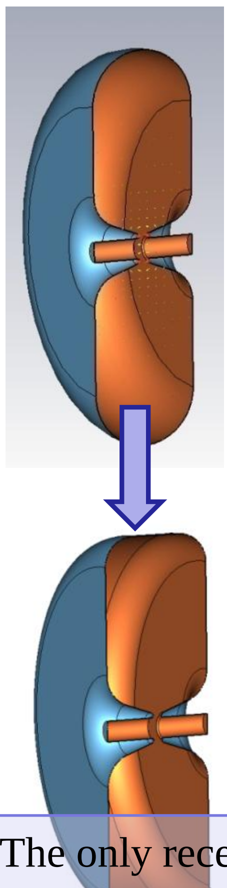
Talk Outline

Project X

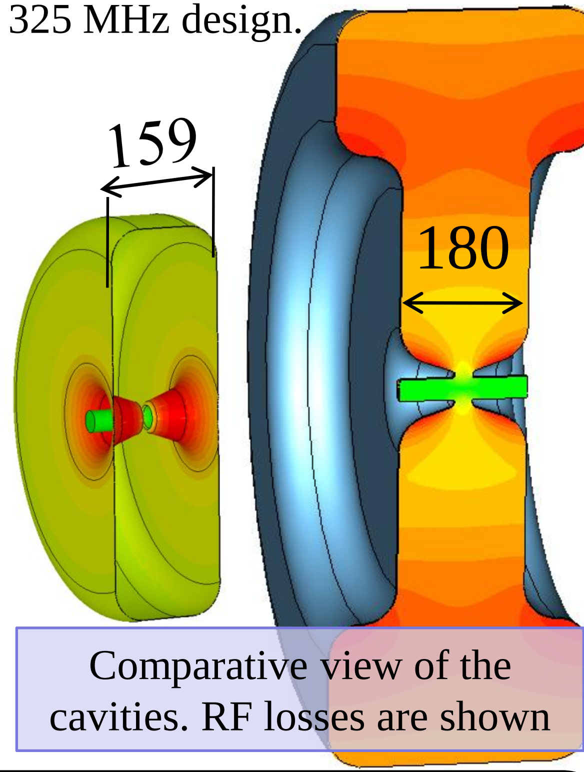
- **Basic RF design of the re-buncher**
- **Mechanical design**
- **Coupled thermal and stress analyses**
- **Conclusion**

162.5 and 325 MHz RF designs

At some point of PrX design it was realized that the present understanding of bunch-by-bunch kickers does not support 352 MHz RFQ. RFQ frequency has been changed to 162.5 MHz. The 162.5 MHz re-buncher has been also evaluated along with the baseline 325 MHz design.



Frequency, MHz	162.5	325
Q factor	27250	28135
Aperture radius, mm	15	15
Gap, mm	25	13
Particle energy, MeV	2.5	2.5
Effect. shunt impedance, Ohm	2.5e6	2.3e6
Max. energy gain, kV	80	46
Power , kW	2.5	0.92
Max. surface field, MV/m	5.5	10.3
Inner cavity diameter, mm	1045	555

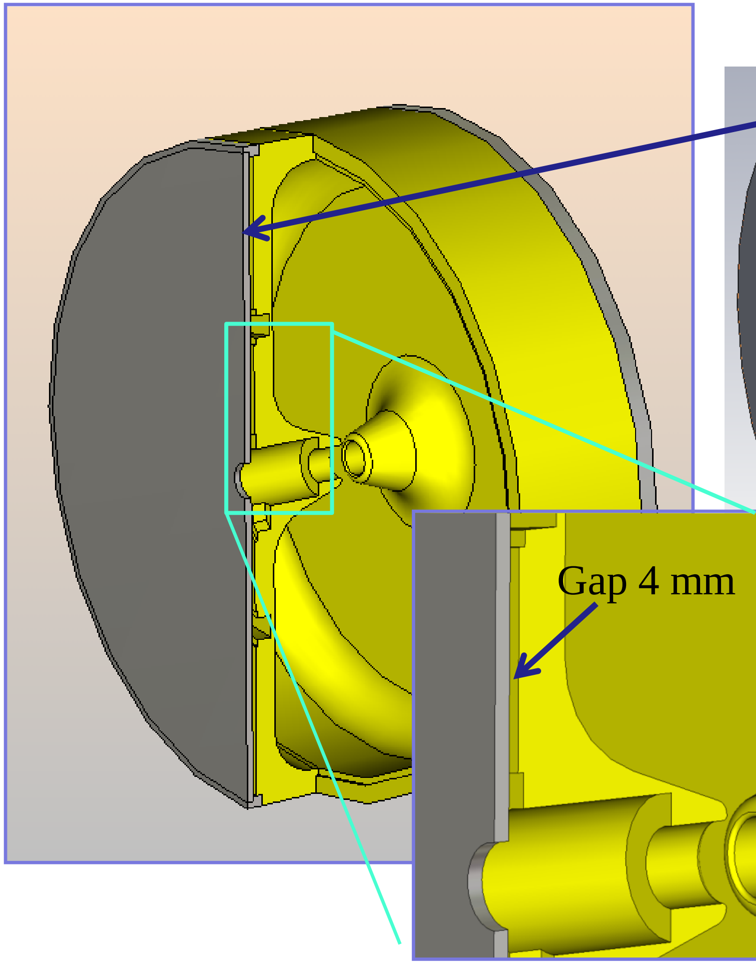


Comparative view of the cavities. RF losses are shown

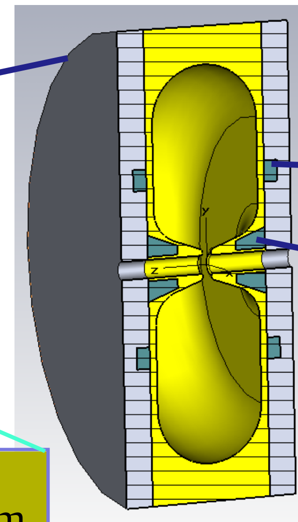
The only recent change in 325 MHz design – flat cylinder generator. Shunt impedance decrease is only ≈2%

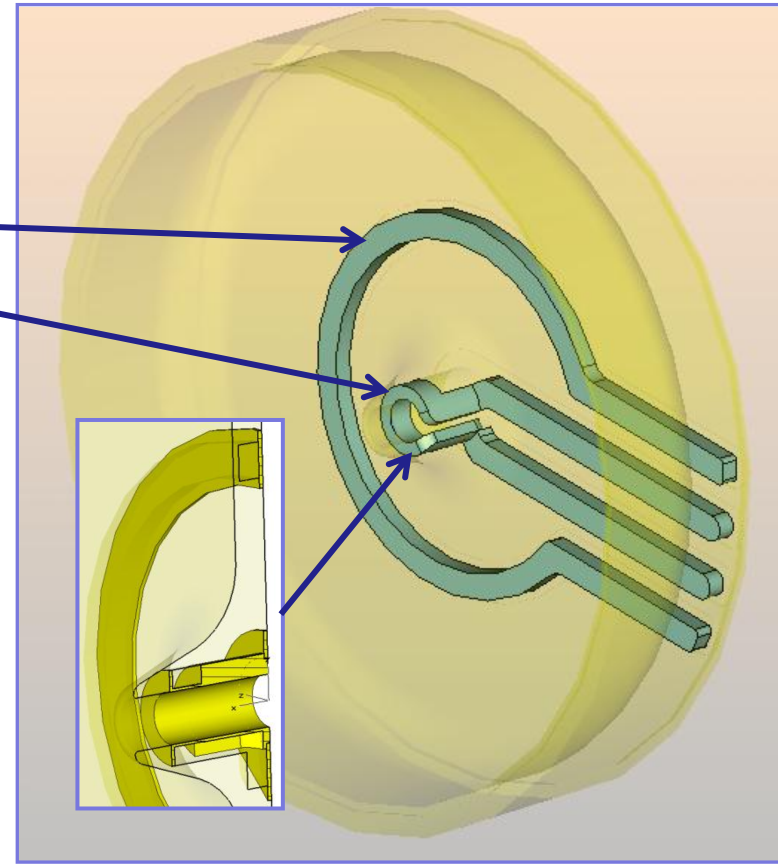
From RF point of view the 162.5 MHz cavity is a competitive design in spite of the big diameter. Especially RF power losses distribution is favorable. But beam dynamic study (Lebedev, Solyak) showed no advantages over 325 MHz version. So, the work on the 325 MHz re-buncher has been resumed.

Mechanical design



Concept

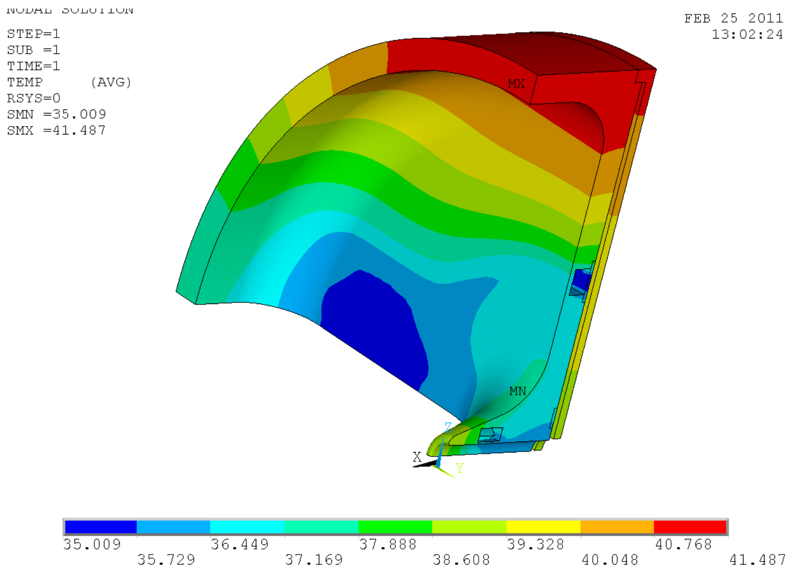


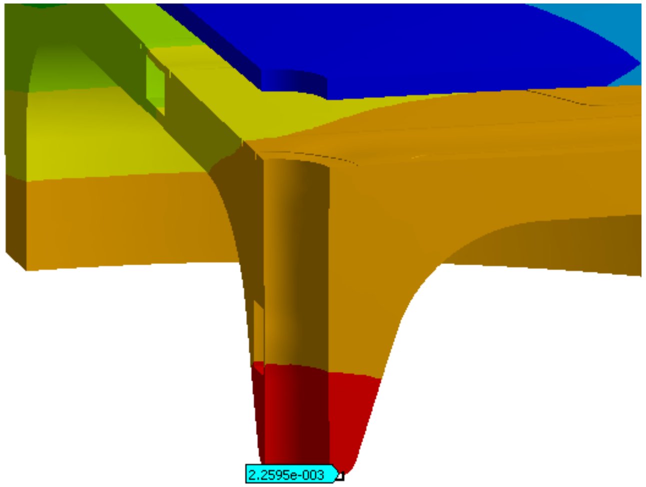


Double end walls, SS and copper plates are separated by vacuum gap

Separate cooling for the body and the drift tubes. A special copper insert provides circular water flow in the drift tube.

Thermal and stress



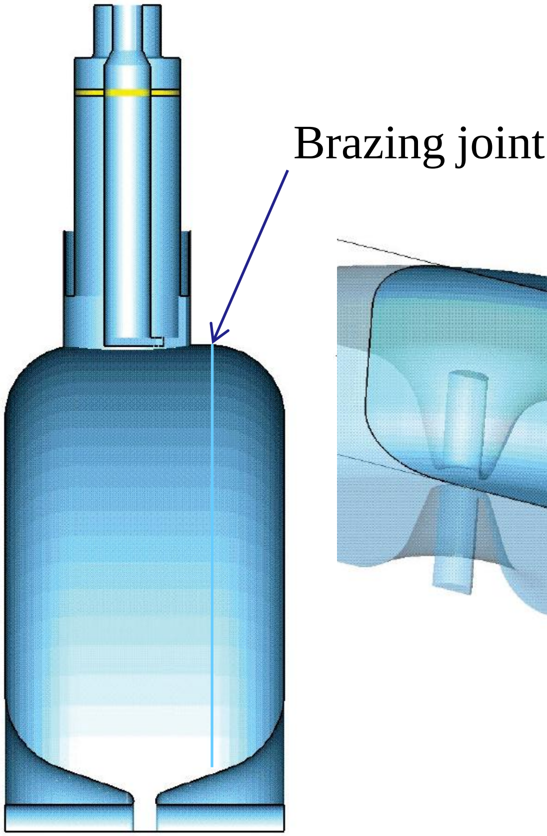


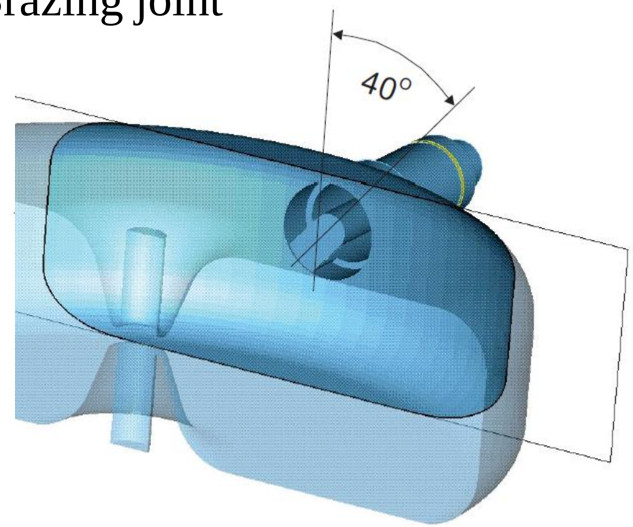
Temperature distribution inside the cavity; maximum 41.5°C, minimum 35°C (inlet water temperature), at the nose 39°C.

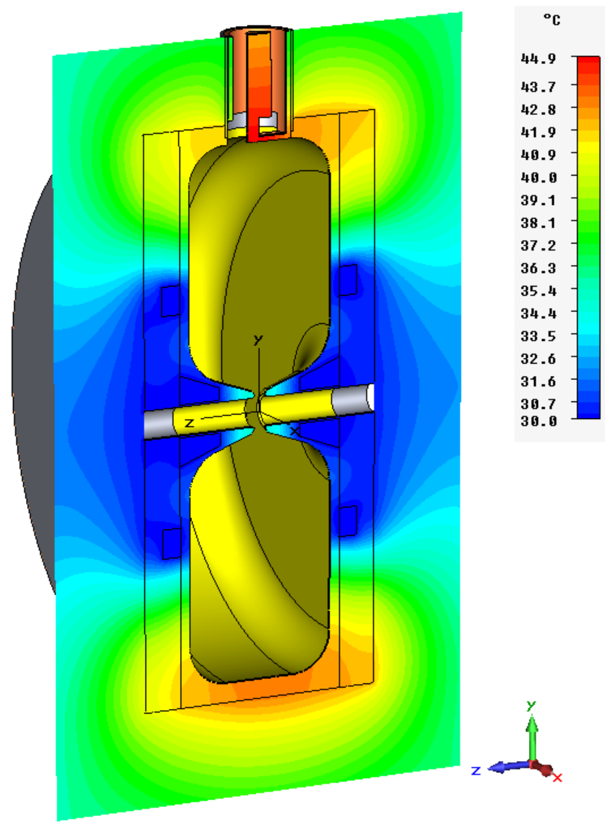
Distribution of thermal deformation. The gap decrease is 6 micron. The frequency shift due to the overall deformation is -23 kHz.

There is no noticeable deformation of the inner copper walls due to the atmospheric pressure and therefore no frequency shift.

HINS coupler







Due to the brazing joint , the coupler position is asymmetrical.
Temperature of the coupler tip is 44.8°C.

JPAW tuner

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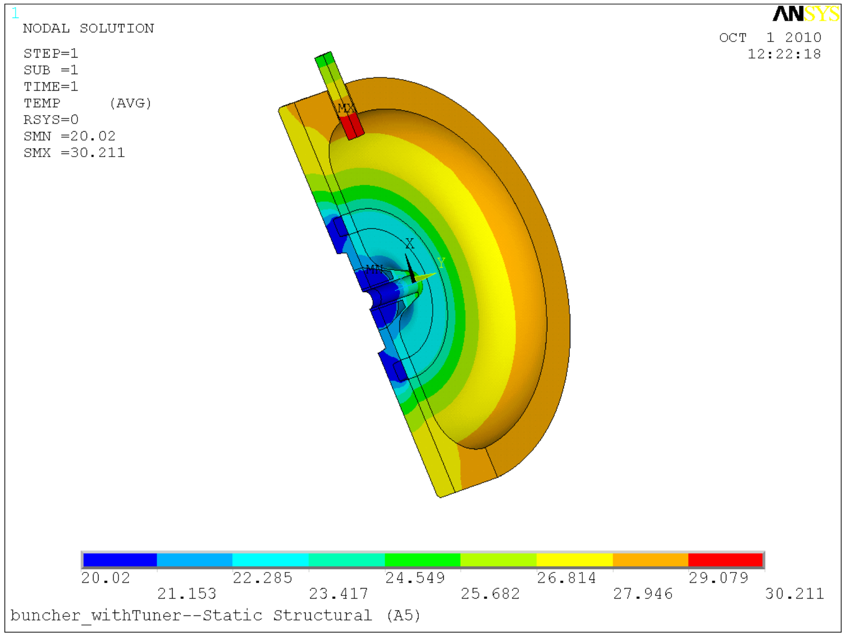

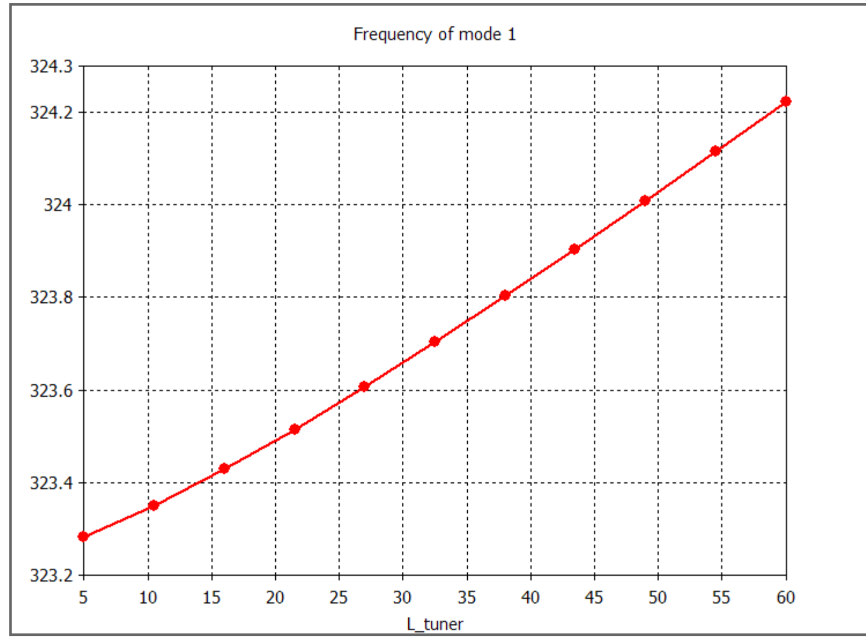

Temperature distribution for the tuner in intermediate position (30 mm penetration)

For inlet water temperature 30°C the tuner tip is 40°C hot.

Frequency vs tuner penetration (two tuners are moving together). The slug diameter is 44 mm, full stroke 60 mm.

Total tuning range of one tuner ≈ 450 kHz.

Conclusion

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- **RF design is complete.**
- **The basic mechanical solutions are made and detailed mechanical design started.**
- **Thermal and stress analyses is complete. Temperatures, deformations and frequency shift are quite acceptable.**